CLAIMS

1. A method of optically analyzing an inhomogeneous medium for determining a physical quantity of a light-absorbing and light-scattering inhomogeneous medium including a plurality of tissues having respective optical characteristics different from each other from light transmitted therethrough or reflected thereby, assuming T to be the transmittance of the medium having a thickness h, and R be the reflectance of the medium, the method comprising:

a first step of making light having a known intensity I_0 at a known wavelength incident on the medium;

a second step of measuring an optical intensity $I_{(R)}$ upon reflection or optical intensity $I_{(T)}$ upon transmission emitted from the medium;

a third step of executing the first and second steps at a plurality of wavelengths and recording the optical intensity $I_{(R)}$ or $I_{(T)}$ as a measurement result; and

a fourth step of calculating a target physical quantity by an algebraic operation including a least-squares method or the like while utilizing a known physical quantity stored in a database and the optical intensity $I_{(R)}$ or $I_{(T)}$;

wherein, when the plurality of tissues are composed of two phases of x and y, the operation of the fourth step is carried out such that the target physical quantity is determined by inputting those known in the following coefficients as known physical quantities stored in the database and the measured optical

intensity $I_{(R)}$ or optical intensity $I_{(T)}$ into those related to arithmetic operations in the following expressions:

reflected light intensity $I_{(R)} = I_0 \times R$

transmitted light intensity $I_{(T)} = I_0 \times T$

$$R = \frac{K(1-\sigma_x)+(1-\sigma_y)}{K(1+\sigma_x)+(1+\sigma_y)}$$

$$T = 4\frac{K\dfrac{\sigma_x}{1+\sigma_x}\exp(-\lambda_x h)+\dfrac{\sigma_y}{1+\sigma_y}\exp(-\lambda_y h)}{K(1+\sigma_x)+(1+\sigma_y)}$$

$$\sigma_x = \frac{\lambda_x}{a_x+2s_x}$$

$$\sigma_y = \frac{\lambda_y}{a_y+2s_y}$$

$$\lambda = \sqrt{\frac{1-F}{2}\left[(1-F)(\rho_x^2+\rho_y^2)\pm\sqrt{(1-F)^2(\rho_x^2-\rho_y^2)^2+4F^2 s_x s_y (a_x+2s_x)(a_y+2s_y)}\right]}$$

$$\rho_x = \sqrt{a_x(a_x+2s_x)}$$

$$\rho_y = \sqrt{a_y(a_y+2s_y)}$$

where λ_x and λ_y are two solutions of λ equation, whereas the coefficients are parameters indicating characteristic features of a nonuniform system and having the following meanings:

ρ_x, ρ_y, σ_x, and σ_y are parameters defined for respective parts of x and y in conformity to a uniform system;

an undetermined coefficient F defining mutual scattering between x and y is used in addition and, by way of the parameters, nonuniform characteristic parameters λ_x, λ_y, σ_x, and σ_y directly ruling a light quantity display in a nonuniform system are defined;

and

the coefficients included in λ, ρ, and σ are as follows:

a_x: absorption coefficient of tissue X

s_x: scattering coefficient of tissue X

a_y: absorption coefficient of tissue Y

s_y: scattering coefficient of tissue Y

K: cross-sectional area ratio of tissues X and Y

F: light quantity redistribution coefficient of mutual scattering between tissues X and Y;

wherein each of (a_x, s_x) and (a_y, s_y) has conventionally been written as (μ_a, μ_s') in an academic literature.

2. A method of optically analyzing an inhomogeneous medium according to claim 1, wherein the mutual redistribution coefficient F is determined by fine structures of tissues and mostly is a constant, i.e., F in the expression is used when the average radius of curvature of the tissue interface is smaller than the photon mean free path, whereas another constant F_2 is used in place of $F_2 s_x s_y$ in the expression when the average radius of curvature is greater than the photon mean free path.

3. A method of optically analyzing an inhomogeneous medium according to claim 1, wherein, by using a relationship in which the physical quantities a_x, s_x, a_y, and s_y are proportional to the concentration of a predetermined target ingredient in the medium, the concentration of the predetermined ingredient is calculated.

4. A method of optically analyzing an inhomogeneous

medium according to claim 1, wherein, when a nonproportional relationship due to multiple scattering or the like exists between the concentration of each ingredient and an absorption or scattering light quantity thereof instead of a usual proportional relationship, a solution is determined by employing a relational equation therebetween which is not linearly proportional.